Investigation of the Mirror Memory Tasks' concurrent validity and sensitivity to temporal lobe dysfunction

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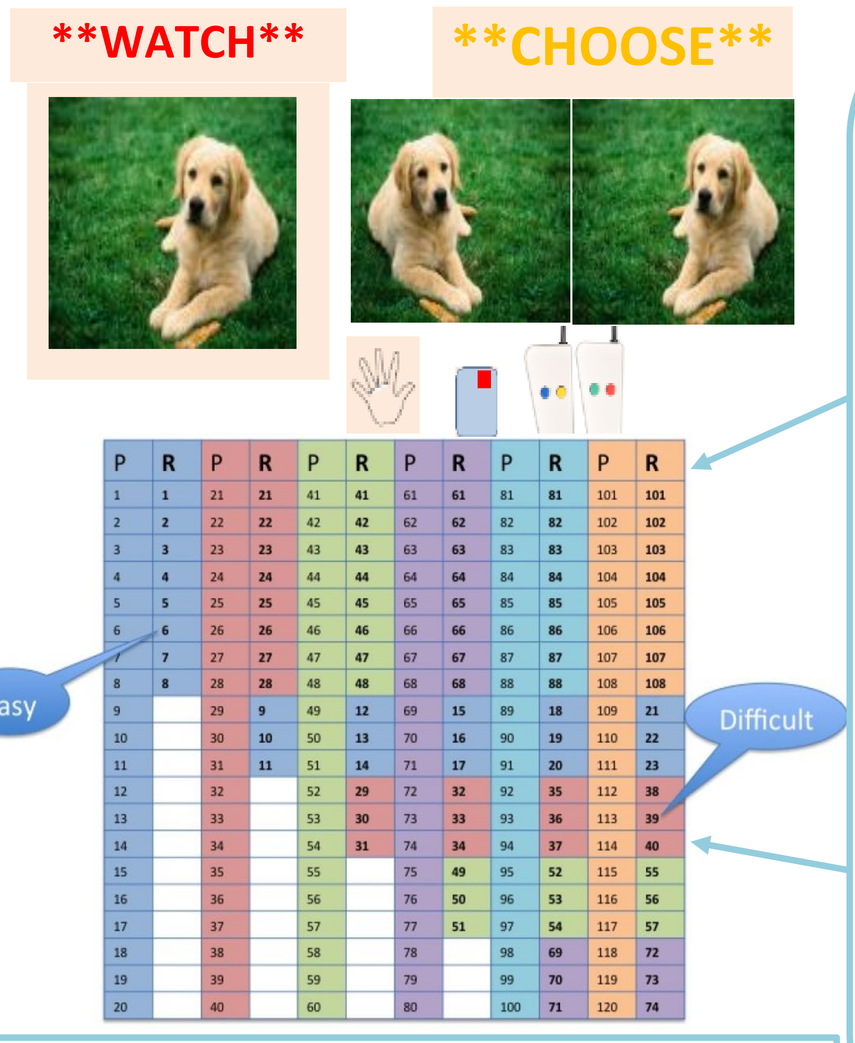
Introduction:

Background: Within Temporal lobe epilepsy (TLE) lateralisation of epileptogenic origination and/or sclerotic tissue to **left** temporal structures is often associated with poor **verbal memory**, whilst lateralisation to **right** temporal structures implicates **visual memory** impairments. Current assessments of **verbal** memory **are sensitive** to left pathology and **widely validated**. Assessments of **visual** memory, however, are **less sensitive** to right pathology and are are largely reliant on sub-serving verbal processes (Castro et al, 2013; Frish & Helmstaedter, 2014). The most accurate measures of right TL function include stimuli which activates visual, rather than verbal, processing.

Current Investigation: Firstly, investigation aims to establish **convergent validity** of the MMT, assessing utilisation within **healthy** populations (adult and paediatric) alongside **gold standard** measures of memory. Secondly, utilisation of the MMT within **clinical** populations (TLE) will be assessed, aiming to identify sensitivity to right temporal lobe pathology.
Overall percentage of correct scores is expected to significantly decline in participants with right unilateral dysfunction.

Mirror Memory Task (MMT): A novel **memory assessment** developed to better measure **visuospatial** processing by using visual stimuli. This maximises right temporal lobe recruitment, promoting the **spatial-encoding** of scenes rather than verbal (Friars et al, 2014; Han et al., 2001).



Task difficulty
As shown above, the presentation of stimuli (P) and recognition trials (R) was structured such that later trials were subject to greater interference. Therefore the difficulty of discriminating true images from mirror images was systematically increased throughout the procedure.

Method:

Eleven patients with epilepsy participated in this study, 5 paediatric patients (mean age = 13.2 years) and 6 adult patients (mean age =41.4 years). All participants completed the MMT, which included **graduated task difficulty**. In addition, paediatric participants completed subtests from the WISC and established memory measures such as the CMS.

During **encoding** (WATCH) trials, participants were instructed to attend to the novel visual stimuli and in particular to its spatial layout *(see image above).*

The **mirror image** of the scene (B) is presented alongside A for participants to discriminate between during a recognition phase of the study

Stimuli were presented in **blocks** of 20 consecutive images. Subsequent **recognition blocks** were presented comprising 8 images from the immediately preceding block and images from earlier blocks.

Analysis: Behavioural data was analysed to determine **encoding success** (hits) **or failure** (misses) during early blocks (predominantly **easy**) versus later blocks (predominantly **difficult**).

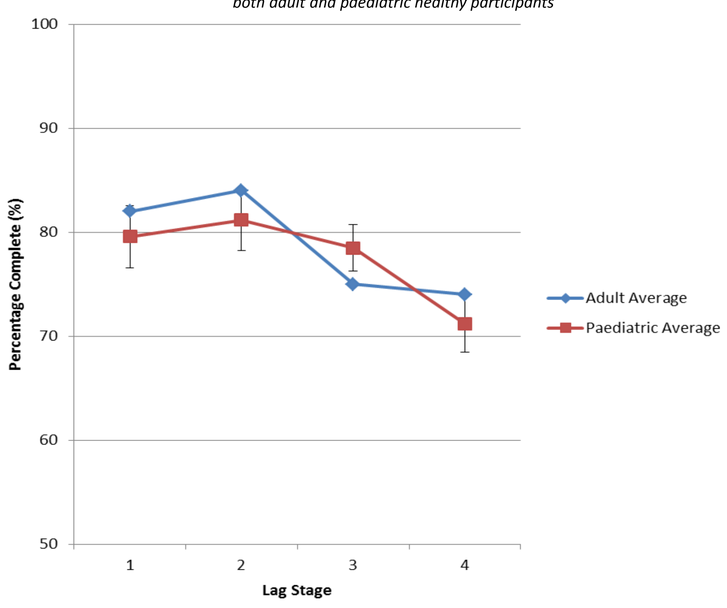
Current Research and Results

Table 1. ***Clinical participant demographic characteristics***

Patient	Gender	Age	Lateralisation	Pathology	CMS (Dots subtest)	WISC (PRI)
1	M	34:02	-	Nocturnal complex partial seizures, temporal lobe semiology		
2	F	13:06	L	Left anteromesial temporal lobe resection; left hippocampal sclerosis	37%ile	45%ile
3	F	23:01	R	Temporal lobe tumour		
4	M	15:01	R	Mass in medial temporal region		
5	M	15:07	R	Right temporal lobectomy; continuing epileptic seizures, previous venous sinus thrombosis	9%ile	61%ile
6	F	9:04	L	Left fusiform gyrus lesion; intractable seizure disorder	63%ile	-
7	F	56:04	Bilateral	Temporal lobe epilepsy		
8	F	61:06	L	Temporal lobe semiology; left hippocampal sclerosis		
9	M	51:01	R	Aura of panic and bilateral tonic seizures		
10	M	29:01	R	Right temporal DNET	-	<0.1%ile
11	M	12:01	L	Epilepsy with 1 seizure type	9%ile	-

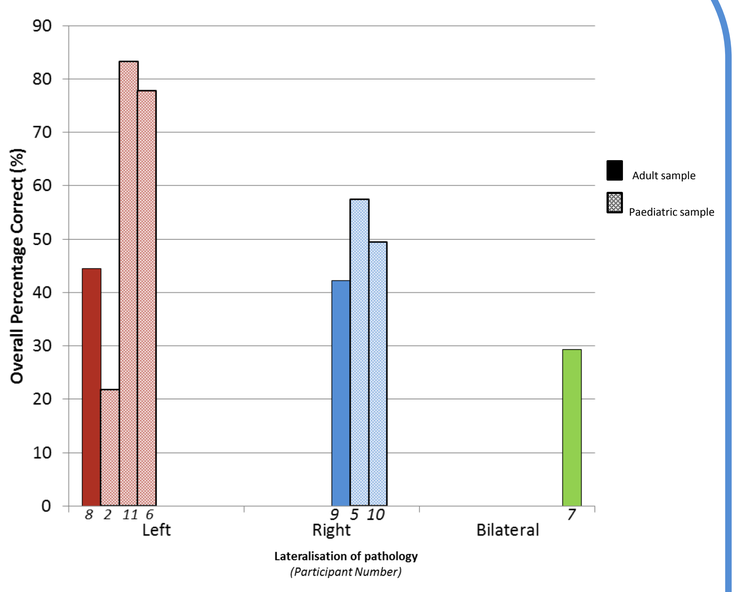
Patient demographic characteristics, pathology, and performance on Gold standard memory test (CMS) and WISC Perceptual Reasoning Index).

Figure 2: The percentage correct (%) of mean scores, across all four lag stages, for both adult and paediatric healthy participants



Behavioural results of healthy adult participants are shown alongside child participants on each stage of lag difficulty on the MMT (Daisley-Devoy et al., 2014; Ryan et al., 2015). Percentage of correct mean scores decrease with task difficulty across both samples, with no significant age-effects found.

Figure 3: Adult and paediatric performance on the MMT, grouped by epileptogenic pathology



MMT Clinical Application (TLE):
-Overall percentage correct, for each participant, is presented and analysed with regard to lateralisation of pathology.
-Participants with **right** unilateral pathology endorse **higher** rates of **incorrect responses** than those with left pathology. This suggests that the MMT may elicit **visuo-spatial encoding** of scenes, rather than verbal, indicating its potential to be a **sensitive** measure in detecting discrete right temporal lobe dysfunction.
-Noted are **possible age effects** within the clinical population, with **paediatric** participants performing better than adults; indicative of potential **neuro-plasticity** and **adaptation**.
-Additionally, a **larger discrimination** of performance between 'left' and 'right' pathology in children may outline an **increased** sensitivity/accuracy of the MMT within the paediatric population.
-Such preliminary results support our hypothesis and enable further investigation into the clinical application of the MMT and its concurrent validity.

Conclusions:

-Behavioural results show good levels of **recognition accuracy** following visual scene encoding.

-Preliminary analysis with patient data suggests that the Mirror Memory Task could be used to **detect visuospatial memory impairment**. In patients with epilepsy, this study demonstrates the sensitivity of the MMT to temporal lobe dysfunction and specifically to visuospatial memory deficits associated with right temporal lobe pathology.

-The conclusions drawn suggest that the Mirror Task is a promising predictor of visuospatial memory ability, which has **high convergent validity** and two levels of difficulty. It further suggests that this paradigm is suitable for **determination** of right hippocampal recruitment for visual memory.

Further Research:
Extension of this investigation will incorporate **fMRI** data with behavioural performance on the task to determine the merit of the MMT in maximising BOLD asymmetry to the right by placing a preferential load on spatial memory.